Alberta Post-War Reconstruction Committee

Rural Electrification

RURAL ELECTRIFICATION

By PROFESSOR ANDREW STEWART
Department of Agricultural Economics
University of Alberta

Reprint of article appearing in the September issue of the FARM AND RANCH REVIEW

INTEREST in the possibility of extending the benefits of electrical power to Alberta farms is growing, and is likely to continue to grow. Early in 1943 the government of Alberta asked the Research Council of Alberta to undertake a study of farm electrification in the Province. Since then widespread interest has been demonstrated by resolutions passed at conventions of farm organizations and of political parties. At the last session of the legislature, the government gave further evidence of interest and concern by introducing a bill for the establishment of a power commission. Among other things, the Alberta Power Commission is making a close study of the problems of rural electrification.

For some time, power companies operating in the Province have been receiving frequent requests from farmers for service. Early in 1943 the two principal power companies, Calgary Power Company and Canadian Utilities Limited, made surveys in farming areas adjacent to their lines; and this summer (1944) these companies are constructing test farm distribution systems in three districts in the Province. These test areas will yield additional useful information on the costs of providing service to farm users. At the Western Conference of the Canadian Electrical Association, held in Calgary in March, 1944, much of the discussion centred around the possibility of farm electrification, and the problems of meeting farm requirements for electrical appliances.

All these developments indicate increasing interest in farm electrification, and suggest that before long something substantial may be accomplished in electrifying Alberta farms. It would be unwise to expect too much, too soon; but, with sufficient interest and concern aroused, progress may be looked for. Much will depend on farm people themselves, and on the amount of effort and resources they are prepared to put into securing this service.

Few Now Served

The Dominion census of 1941 recorded 5.5 per cent of the farms in Alberta electrified. As there are approximately 100,000 farms in the Province, this means that about 5,500 farms have electricity. From information available it appears that about 500 farms secure central station energy from transmission lines; the remainder have individual farm plants, either gasoline or wind-driven. Fifty-five per cent of the farms in the Province lie sufficiently close to high-voltage transmission lines that they could be served from these lines by relatively low cost farm distribution

lines. Why then are there so few farms served with central station power? The answer to this question is important because it suggests the problems which must be met and solved, if large numbers of farms are to be electrified.

There seem to be three main reasons for the small number of farms now served with central station power. These reasons are, first, the high overhead cost per farm; second, the irregular and uncertain incomes of farm families; and third, the small consumption of energy per farm. These conditions have made the extension of lines to isolated farms unattractive to power companies which have to expect to cover their costs out of the rates charged for energy.

The costs of farm line construction *per farm* depend upon the cost of construction per mile of line, and the number of customers per mile. At best distribution lines are costly to construct. Their construction requires expensive materials and much labour. To distribute energy it is necessary to install a substation on the high voltage line; and with farms located as *they are*, a small transformer must be installed at each farm to reduce the voltage for utilization. Distribution lines must be laid on or close to road allowances so that they can be easily patrolled. For protection it is necessary to install a substation on the each mile. A few years ago the standard estimate for constructing farm distribution lines was around $1,000 per mile. With increasing interest in serving farm customers, electrical engineers have turned their attention to devising a low-cost type of distribution line. Today if materials were available, farm distribution lines adequate to provide a reliable farm service could be built for between $500 and $600 per mile, not including the transformer at the farm. This substantial saving has increased the possibilities of farm electrification.

Frequency of Customers

The other factor affecting the cost of construction per farm is the number of customers per mile. This depends on the density of farms in any area, and on the proportion of farms connected to the line. The density of farms varies with the size of the farms; and the importance of size may be seen by comparing the proportions of farms electrified in Alberta with the proportions in other provinces. The average size of farm in Alberta is about 400 acres; and 5.5 per cent of the farms are electrified. In Ontario and British Columbia the farms average 119 and 136 acres respectively; and the proportions of farms electrified are 37.0 per cent and 35.8 per cent (1941). If all of the farms were to be served in any area, the cost of line construction per farm would be about half what it would be if only 50 per cent of the farms along the line were connected. The "saturation" of farms connected in any area is therefore of great importance in reducing overhead costs per farm; and is particularly important where farms are large and dwellings scattered.

The second reason for the small number of farms now electrified with central station power is the irregular and uncertain incomes of farm families. Between 1926 and 1937, the average net cash income per farm in Alberta has been estimated at approximately $1,467 in 1928 and $165 in 1932; the average for the twelve-year period being $628. Under conditions such as these the risk to the distributing utility is great, and power companies have found that, during years of depressed farm incomes, many of their customers have had to discontinue the use of electric energy. A reasonable measure of stability of farm incomes appears an essential prerequisite to any general scheme of farm electrification.

The third factor associated with the small proportion of farms electrified in Alberta is the small consumption of energy per farm. To ask a power company to construct a mile of line to a single farm is comparable to asking a milk distributor to build a special road to take a quart of milk a day to a customer. It is difficult to estimate

accurately what the average consumption of energy per farm would be over a large number of farms in Alberta. There is much variation in other provinces, and the Alberta farms now using central station power are not typical farms. In the area served by the Shawinigan Power Company in Quebec, the average consumption is less than 400 kwhr per farm per year; in Ontario it is 1700 kwhr; and in B.C., 700 kwhr. Farms served by the Calgary Power Company average over 1300 kwhr per year. Supposing that 30,000 Alberta farms were electrified, and that the average consumption was 750 kwhr, total farm consumption would then be 22½ million kwhr a year. This represents about 7 per cent of the total electrical energy generated in Alberta in 1942. It is evident from this that the prospective farm consumption of power is a relatively small matter.

Low Consumption

There are two reasons for the small consumption of energy per farm. These are first, electric energy is practically confined to stationary uses and, on many farms, alternative sources of power are available for some stationary uses; and second, the household appliances usually first installed when farms are connected do not use much energy. An increasing proportion of Alberta farms are equipped with tractors, and it would seem unwise in most cases to install large and expensive electrical motors for belt work which can be performed by the tractor already on the farm. Experience elsewhere indicates that the most popular electrical appliances on farms are the hand iron, radio, washing machine, and toaster. These are the only appliances found on more than 50 per cent of the farms electrified in Ontario.

The combination of heavy overhead, uncertain income of farm customers, and small consumption per farm has made the provision of electrical energy a hazardous and relatively unattractive field for private utilities. It is well to keep these aspects of the problem in mind; not because the difficulties they present are insuperable, but because the successful provision of central electric station power to any large proportion of farms in Alberta depends on first, a high saturation of farms in areas served by farm distribution lines; second, reasonable stability of farm incomes so that farmers may be able to pay their bills; and third, promotional and load-building activities to increase farm consumption and reduce the unit cost of providing energy to farm users.

RURAL ELECTRIFICATION

By PROFESSOR ANDREW STEWART
Department of Agricultural Economics
University of Alberta

Reprint of article appearing in the October issue of the FARM AND RANCH REVIEW

2. Power Resources and Facilities in Alberta

THE Province of Alberta has substantial and varied resources capable of providing the people of the Province with electric energy. These resources include water, coal, oil and wind.

The available estimates of water power which could be developed in Alberta suggest that the resources in this Province are not large in comparison with the potential water power in the provinces of Quebec, Ontario, Manitoba, and British Columbia. However such estimates, while they may be the best that can be made, do not provide any reliable or useful inventory of the power potentialities in any province. They are based on sites which have been investigated, and on the natural fall of water. In Alberta, as elsewhere, power capable of development can be greatly increased by the construction of storage basins and other regulating works. In any event it is apparent that there is ample potential water power in Alberta for any uses that can be visualized at present; but it must be recognized that many of the more favourable undeveloped sites are located at some distance from the settled part of the Province. Substantially all of the hydro-electric energy now developed in Alberta is generated in four large plants located in the mountains west of Calgary. These four plants are owned and operated by the Calgary Power Company, and have a capacity of 91,000 h.p.

As is generally known, Alberta has very large supplies of coal. It would be useless even to try to estimate the amount of energy that could be generated through steam plants. Steam plants can be located anywhere, but, because water supply is also important in operating a steam plant, such plants are usually found in towns or cities located by rivers or lakes. The total horsepower capacity of steam plants now operating in the Province is 111,156 h.p. The largest steam plant in the Province is the Municipal plant in the City of Edmonton. The capacity of this plant has recently been increased to 65,500 h.p. Other substantial steam plants are found at Lethbridge, Medicine Hat, and Drumheller.

Alberta has also large known supplies of oil, but relatively little of the annual production is used for generating electrical energy. Diesel plants are found operating in towns and villages distant from alternative sources of power. As these centres are usually small, the diesel plants in the Province are generally small. Larger plants include those in Grande Prairie and Cardston. The total generating capacity of gas and oil engines used for generating purposes in the Province is reported to be 5,887 h.p.

Gasoline and wind also provide sources of power for small plants in commercial establishments in villages, and on farms. There are apparently about 5,000 of these plants on Alberta farms, but information is not yet available to indicate how many are driven by gasoline and how many by wind. Neither is it possible to tell where they are mainly found in the Province, although it is known that the proportion of farms with individual plants is quite high in some districts. Information on the use of farm plants is being gathered by the Alberta Power Commission.

The electric energy distributed over high voltage transmission lines is mainly generated in hydro-electric stations; one system of lines is energized from a steam plant and another from a diesel plant. The most extensive transmission systems are those of the Calgary Power Company. The lines constructed by this Company extend from Milk River and Glenwoodville in the south of the Province to Clyde and Westlock in the north. The main lateral lines run east to Brooks and to Provost, and west to Nordegg. Canadian Utilities Limited operate three transmission systems. The steam plant at Drumheller serves a system of lines which extend north as far as Forestburg and east to Coronation. Another system is interconnected with the Calgary Power hydro system south of Vegreville, and runs north to St. Paul and east to Lloydminster. The third system of Canadian Utilities is supplied by the diesel plant at Grande Prairie and extends from Sexsmith to Hythe.

Voltages Are Generally 13,000, 22,000 and 33,000.

The lines constructed by the two companies provide a well-developed distribution system by which most of the towns and villages in the more densely populated parts of the Province are served with power. Apparently all but nineteen of the incorporated places in the province have electricity, and at least 126 unincorporated hamlets are served. Out of 308 centres served with electricity in 1942, 172 were served from the lines of the Calgary Power Company, 62 by Canadian Utilities Limited, 10 by municipally-owned plants, and 64 by independent commercial stations.

As pointed out in the preceding article, the transmission lines already built bring central station power within twelve miles of approximately 55,000 farms, or 55% of the farms in the Province; but only about 500 farms were connected to the lines in 1943. The number of farms connected will be increased to about 700 with the completion of the test farm areas being constructed by the companies this summer (1944). However, it is clear that the resources exist and that the facilities now are available for taking central station power to a much larger number of farms. The connection of any large number of farms depends upon whether energy from the high wire line can be offered to farmers at rates which they will be able to pay. The costs of constructing farm distribution lines, of operating these lines, and of energy at the farm will be dealt with in the next article.

The alternative to central station power is the individual farm plant. This subject will also be discussed in a later article. The available evidence suggests that, where a sufficient number of farms can be connected to farm

distribution lines, and if the consumption per farm is built up, the cost of providing central station power to farms is lower than the cost of providing comparable service through the individual farm plant. However, farmers in the Province who now operate their own plants generally express themselves as well satisfied with the service they receive. Moreover, there are many areas in Alberta in which the density of farms is so low that the number of connections per mile would mean a very heavy overhead in distribution lines. Consequently, even if substantial progress can be made in extending central station power to Alberta farms, there are many farms which could be more economically served by the individual farm plant. This type of plant has a real place in the Province of Alberta.

RURAL ELECTRIFICATION

By PROFESSOR ANDREW STEWART
Department of Agricultural Economics
University of Alberta

Reprint of article appearing in the November issue of the FARM AND RANCH REVIEW

3—Line Construction Costs and Probable Users Per Mile.

THE capital charges on investment in farm distribution lines, that is, interest and depreciation account for a substantial part of the total cost of supplying energy over these lines. In order to keep down the costs per farm it is therefore desirable that the investment costs per farm should be as low as is consistent with safe, reliable, and adequate service. The cost of construction per farm depends on the cost per mile of line, and on the number of users per mile.

Given the prices of equipment and materials and the wages of labour, the cost of farm line per mile depends on the type of line constructed and the service offered. The type of line which is proposed for farm electrification in Alberta is a 6,900-volt single phase line. The power would be taken off the existing high voltage transmission lines, and stepped down to 6,900 volts. For this purpose a 50 K.V.A. transformer would be used, and it is expected that this would serve about 100 customers. The farm distribution line would carry power out to farms up to 12 miles from the substation on the transmission line. A 1½ or a 3 K.V.A. transformer would have to be installed at each farm to deliver electricity at 115-230 volts to the user.

This type of line is similar to that in use in the Rural Electrification Administration systems in the United States, and in the rural lines of the Hydro Electric Power Commission of Ontario. It is the type of line being constructed by the companies in the test systems they are building in Alberta this year. The line is designed for low cost. Motor sizes on farms would have to be limited to 3 h.p., but this would be sufficient for all the common uses on the farm with the exception of crushing grain with a large crusher. More elaborate service to meet the power requirements of this operation could be provided only at considerably increased cost, and, while the convenience of a large electric motor for crushing is undoubted, it would be questionable policy to instal a motor with capacity greatly in excess of what is normally required for this one operation. A small

grain crusher is in use on Ontario farms, and tests are being made at the Olds School of Agriculture this summer.

The cost of materials going into the construction of farm lines can be illustrated from estimates prepared for an area in the Stettler district. This estimate is based on 19.8 miles of road line and 0.9 miles of farm service run off. Poles and attachments on road lines would cost $165 per mile, and conductor (wire), $112 per mile. Poles, wire and other materials on the service run offs would cost $1,073 per mile. The total cost of materials on 20.7 miles of road line and run off would be $6,536, or $316 per mile. These figures do not include labour, trucking and other costs. Additional material would include the substation on the main line ($305), and the transformers at the farm ($111 each).

The line costs per farm (but not the additional service costs per farm) depend on the number of users per mile. This in turn depends on the density and scatter of farms in the area, and on the proportion of farms connected, that is, the saturation. In order to get some reliable estimate of the probable customers per mile of line in Alberta, township surveys were made in 18 districts covering all of the area within 12 miles of the existing transmission lines. The number of farms per township (including farms within one-half mile from the township boundaries) ranged from 42 in the Castor district to 130 in the Ellerslie district south of Edmonton. As some farms would not be expected to connect to the lines, an effort was made to rate the farms as prospective users of power. The estimated proportions of users (estimated saturation) ranged from 34% in the Mundare district to 70% in Ellerslie. From the location and rating of farms the probable connections were estimated to range from 0.90 connections per mile in Castor to 2.11 connections per mile in the irrigated district around Brooks. The average over all the 18 surveys was 1.35 connections per mile.

Using the estimates of construction costs per mile, the probable connections per mile and the additional farm service costs, the estimated cost of construction per farm ranged from $455 in the Brooks district to $759 in the Castor district. The average cost over all districts was close to $600 per farm, with a saturation of 54% and with 1.35 farms per mile of line and tap-off. This estimate covers all construction costs involved in taking power up to the meter at the farm buildings. The farmer would have to wire his own buildings and purchase his appliances. An average figure for wiring buildings might be $150, and the cost of appliances might at first average around $300 per farm.

While there is considerable difference between districts, the probable users per mile in Alberta is generally low. This is one of the principal difficulties in providing central electric station power to Alberta farms. The rural lines of the Ontario Hydro Commission serve 3.0 hamlet and 3.5 farm customers per mile, and the Commission will not make extensions unless 3 or more users per mile are available. In typical districts in Quebec and New Brunswick the number of users per mile is around 6. In Nova Scotia assistance is given only where the equivalent of 3 domestic users per mile can be obtained. These provinces, with British Columbia where the number of users per mile is also high, are the provinces with substantial proportions of farms electrified.

While the average number of users per mile in Alberta is relatively low, there are many districts in which the density of farms is sufficiently high to keep down overhead costs to a reasonable level, *provided most of the farms in the district were connected to the lines.* The proportion of farms which

might be connected depends largely on farm incomes, and so it appears that any considerable extension of farm electrification by central station power is dependent on stability of farm incomes, at a level which will enable farmers to wire their buildings, install electrical equipment and appliances, and pay their monthly bills. The rates and monthly bills which might be necessary if all costs had to be met out of revenues will be discussed in the next article.

Probably the most effective way of reducing construction costs per farm and therefore capital charges per farm, would be to increase the proportion of farms connected to the lines. For example, it has been estimated that, in the surveyed areas, if all the farms within one-half mile of the line could be connected, this would raise the saturation to 71% and reduce construction costs by nearly $60 per farm.

A second possible means of reducing costs would be to have the farmers assist in the construction work. While this procedure has been adopted in some of the Rural Electrification Administration systems in the United States, it has been found to have limitations in reducing costs. In the first place, much of the work requires special skill and must be done by trained men. Secondly where farmers give their time to assisting in line building they may expect to be credited with the time spent on the job. This is generally done in the "self-help" systems of the R. E. A.

Construction costs could also be reduced if materials were available at lower prices. The prices used in estimating construction costs were those prevailing in Calgary in 1943. Prices of electrical materials in the United States are significantly below those of materials offered by Canadian manufacturers. Free entry of materials produced in the United States would also tend to reduce farm line construction costs in Alberta. Canadian prices might be lower at a time when construction could be undertaken, and if a general scheme were planned some savings might be expected through bulk purchases contracted for over the period of construction.

RURAL ELECTRIFICATION

By PROFESSOR ANDREW STEWART
Department of Agricultural Economics
University of Alberta

Reprint of article appearing in the December issue of the FARM AND RANCH REVIEW

4—Monthly Costs and Rates.

REFERENCE was made in the preceding article to the costs of constructing farm distribution lines. From the enquiries referred to in that article, it has been estimated that by building farm distribution lines off the existing high voltage transmission lines, 30,000 farms in the Province of Alberta could be connected at an average cost of about $600 per farm.

If all costs had to be met out of rates, these costs would include the capital charges on the investment in farm lines, the operating costs involved in supplying power to customers on the line, and the cost of energy at the farm.

Capital charges include interest and depreciation. The precise rate of interest which would be involved in financing line construction depends on a number of factors which cannot be accurately predicted. Assuming that funds for this type of project were available at 3% per annum, the charge for interest would be equivalent to $1.50 per month. Because of the limited experience with farm distribution lines, the rate of depreciation is also difficult to estimate accurately. If the average life of the lines were 25 years (depreciation of 4% per annum) replacement could be provided for by a sinking fund levy of 2.75% per year. The charge to cover replacement would then amount to $1.38 per month. This would bring the total monthly charges on fixed capital to $2.88 per month.

The main items of operating costs are line operating expenses, billing and collection, promotion and load-building, and administrative expenses.

Line operating expenses include salaries and travelling expenses of men engaged in patrolling and servicing lines, materials for repairs, and the maintenance of meters and transformers. Costs of billing and collection would be high on rural lines if farm meters were read and collections made monthly as in urban centres. Promotional activities are those designed to increase the number of connections and to build up consumption of energy on farms. In the initial stages considerable expenditure for this purpose would be justified. Ad-

ministrative expenses are those overhead office expenses which have to be distributed over the customers served. Once again, lack of experience limits the possibility of accurate estimate of operating expenses. The Electrification Enquiry Commission appointed in Manitoba in 1942 estimated that total line operating expenses might amount to $1.99 per month, and a similar figure might cover the expenses in Alberta.

Information made available by the Companies generating power in Alberta suggests a cost of 1.00 cents per kwhr at the generating plant. To arrive at the cost of energy at the farm allowance has to be made for line losses. These are estimated at 40%, which would bring the cost per kwhr at the farm to 1.65 cents.

Based on these estimates, the total cost of supplying 50 kwhr per month would be $5.70, made up of $2.88 capital charges, $1.99 operating costs, and 83 cents for energy.

Assuming that total costs, as estimated, had to be met out of revenue from the sale of energy to farm users, the following rates would appear to be necessary:

> Minimum net monthly bill of $4.80 up to 20 kwhr
> (Discount at 10% off the even dollar.)
> Additional consumption over 20 kwhr, 3 cents net.

It will be seen that these rates would cover costs at an average consumption per farm of 50 kwhr per month.

First 20 kwhr	$4.80
Additional 30 kwhr	0.90
Total net bill	5.70

Possible means of reducing construction costs below $600 per farm were considered in the preceding article. There is a variety of procedures by which the rates suggested above might be reduced.

First, these rates are based on the assumption that all costs incurred in supplying energy to farm users were to be covered by revenues from rates charged. In fact, there are few situations where any substantial proportions of farms are electrified in which this principle is employed in farm rate setting. For example, the Shawinigan Power Company, which is the principal utility supplying farm customers in Quebec, claims to lose $350,000 per year on the service it provides to its farm customers. This, of course, means that rates being charged to other users are sufficient to compensate the Company for the loss it sustains on its farm systems. Again, in Ontario, the Provincial Government has contributed in grants-in-aid to rural electrification an amount equivalent to $180 per rural customer. Rates to farm users in Alberta could be reduced below those suggested if some method of absorbing farm line losses were adopted, either through revenue from the sale of power to other classes of users, or out of the general revenues of the Province.

Second, the rates suggested are based on an extensive scheme covering 30,000 farms. Costs per farm, and rates, could be reduced if a plan for providing central station power to farms were limited to those areas in which there is a relatively high density of farms, and in which a relatively high saturation could be expected. For example, it has been estimated that if the construction of farm lines were limited to areas capable of providing 1.75 connections per mile, construction costs per farm might be reduced some $75 per farm. Perhaps 10,000 farms could be electrified under these conditions.

Third, there may be some opportunities of reducing operating costs, and rates, through local assistance in patrolling lines and in connection with meter reading, billing and collections. The reductions which might be effected

in these ways are possibly limited, but are worth consideration and investigation.

On the other side, it must be noted that some of the costs included in the estimates are perhaps lower than they would prove to be in practice.

In the first place, the estimates are based on the assumption that little risk is involved in the investment required, that farms connected to the lines will remain users, and that there will be no serious problem of disconnections, collections or bad debts. On the basis of past experience of farm incomes it is doubtful if private capital could be attracted to this form of investment at an interest rate of 3%. The risks would appear to be too great. Even where public funds were made available at so low a rate, the risk would still remain as long as farm incomes were likely to be as irregular as they have been in the past. It is therefore again evident that, if rates are to be low enough to induce a substantial number of farms to take central station power, difficulties can be avoided only if farm incomes are in the future more stable than they have been.

Secondly, at least for a time, expenses for education and promotion might well be higher than those allowed for in the estimate of costs. However, agricultural education and research has long been accepted as a responsibility of government. In view of the general advantages which might be expected to follow farm electrification, it would seem reasonable for governments and government institutions to participate largely in the educational and promotional work required.

RURAL ELECTRIFICATION

By PROFESSOR ANDREW STEWART
Department of Agricultural Economics
University of Alberta

Reprint of article appearing in the January issue of the FARM AND RANCH REVIEW

5—The Organization and Financing of Farm Service.

FARM electrification using central station power, presents some special problems of organization and financing. These problems result primarily from the effects of the wide scatter of farms on construction and overhead costs, and on the administration and operation of rural systems. In the past the problems have been complicated by the relatively low and variable farm incomes.

Study of the organization of power distribution in rural areas in the Provinces of Canada indicates little uniformity of procedure. While power commissions have been established in most of the Provinces, their participation in the actual business of power distribution varies considerably.

For example in Ontario and Manitoba the provincial Commissions have been active in promoting rural electrification and in serving rural areas, but, until recently, the basis of operation has been significantly different, and the proportion of farms electrified is much higher in Ontario than in Manitoba. In Manitoba distribution of power, outside the metropolitan area of Winnipeg, was centralized in the hands of the Commission, and a policy of uniform rates was followed. In Ontario the Commission provided power to rural districts which controlled distribution and rate setting. This system resulted in a highly diversified rate structure over the Province. Recently the Ontario Hydro Commission has consolidated the distribution of power under Commission control in a manner similar to the procedure in Manitoba.

In Quebec and British Columbia rural centres and farms have been served exclusively by private companies, and the proportion of farms electrified is high in both provinces.

The position in Nova Scotia is intermediate between these two extremes, although a high proportion of the farms electrified are served by the Nova Scotia Power Commission. When applications are received for service of farms close to the lines of a private company, the company is given the opportunity to construct the lines and to provide service within the district. If the utility does not undertake the

service within a stated period of time, the Commission may itself make provision to distribute power the power being purchased from the company. The proportion of farms electrified in Nova Scotia is relatively high, although not as high as in Ontario and British Columbia.

The operations of the Rural Electrification Administration in the United States illustrate still another form of organization. Under this system farm distribution is undertaken by co-operative organizations. Farms in other areas may be served by private companies. (It may not be generally known that there are four small farm electrification co-operatives in Alberta. Three of these purchase their energy from the City of Edmonton.)

The R. E. A. assists in the organization of the co-operatives which, in the majority of cases, purchase energy from private companies already engaged in generating and transmitting power. The Administration has been successful in organizing districts covering large numbers of farms, and in stimulating private companies to extend service to farm customers. However, in interpreting the United States' experience, two points are significant. First, the systems have developed during a period of buoyant farm incomes, beginning in 1935. Second, there is a noticeable tendency for the systems to be developed in the relatively favourable areas. Participation in the west-central states (where conditions are more comparable to those in Alberta) is relatively low, and within these states only the areas of greater density of farms are being served.

Canadian experience suggests that except under the most favourable circumstances, it is difficult if not impossible to make the revenues from the sale of power to farm users cover all the costs of providing the service. The United States' experience indicates that progress can be made on this basis. The R. E. A. systems are assisted only in organizing and in the provision of loans at low rates of interest. So far the experience with the loans has been highly satisfactory. But the R. E. A. systems have been slow to develop in states with conditions comparable to those in Alberta. There are some areas in Alberta, for example around cities and in the irrigated areas, in which farms could be served out of the revenues from the sale of power, but the number of farms in such favourable situations is relatively small.

When an organization is selling power to urban domestic, commercial and industrial users, and also to farm customers, it is difficult to segregate the costs and to determine whether different types of users in different locations are meeting the full costs of providing the service to them. Rates are not perhaps cannot be, closely related to the particular costs of serving particular customers.

Many private companies distributing power to rural users claim that they incur losses in connection with their rural services. This may well be the case. However, as long as the companies remain solvent it is evident that their losses from farm services must be balanced by the gains from servicing urban and industrial users. In this event, the urban users are contributing to the servicing of farms. This is one way of securing the electrification of farms.

In Ontario, the Province with the largest proportion of farms electrified, the Provincial Government has for many years followed a policy of direct financial assistance to rural electrification. Grants-in-aid have been made to cover fifty per cent of the initial costs of line and secondary equipment necessary to take power to the farm property. By the end of 1941, the grant-in-aid totalled more than $23 millions, and represented $160 per customer. The Commission has also made

advances to assist farmers in the purchase and installation of electrical appliances.

In Manitoba, the Manitoba Power Commission Act has provided for a bonus equal to the interest and sinking fund on one-half the capital cost of taking power to rural centres. The Manitoba Electrification Enquiry Commission, which was appointed and reported in 1942, recommended that the same assistance be made available to aid in a programme of farm electrification. The acceptance of this recommendation would place assistance to farm electrification in Manitoba on a somewhat similar basis to that in Ontario. The Enquiry Commission estimated the amount of the bonus at approximately $35 per farm per year.

In a previous article in this series reference was made to certain estimates of construction costs for the electrification of 30,000 farms in the Province of Alberta. The capital cost per farm was estimated at $600 per farm. Assuming interest at 3 per cent and an annual sinking fund levy of 2.75 per cent, the capital charges per month would then be $2.88. If the principle of assistance recommended in the report of the Manitoba Enquiry Commission were applied to such a project in Alberta, the provincial contribution would then amount to $17.28 per farm customer per year, and, at the end of ten years with 30,000 farms connected, would in the aggregate amount to over $500,000 a year.

Under a less extensive project covering a smaller number of farms, in selected areas of greater density of farms, capital costs per farm could be reduced, and the assistance necessary to support equal rates would be correspondingly smaller.

RURAL ELECTRIFICATION

By PROFESSOR ANDREW STEWART
Department of Agricultural Economics
University of Alberta

Reprint of article appearing in the February issue of the FARM AND RANCH REVIEW

6—The Individual Farm Plant

PRECEDING articles in this series have dealt largely with the use of energy generated in central electric stations, transmitted over high-voltage lines, and distributed to farms over lines of lower voltage. If cost were no consideration this source of power would always offer advantages over alternatives. It is flexible, and to secure power at any time the farmer has merely to turn a switch. But cost must be considered, if only as a means of choosing between alternatives. Wise choice will depend upon the relative costs under different conditions, taking into consideration those advantages and disadvantages which cannot be measured in dollars and cents.

It has been repeatedly emphasized that the costs of power line construction per farm vary with the number of connections per mile. As farms become more sparse and connections per mile fewer, the costs of providing central station power increase. On the other hand the cost of the individual plant per farm remains constant. Consequently at some point of density of farms the advantage shifts over to the individual plant.

The desire for electric power shown by farm people, the action already taken by the power companies in establishing test areas, the evident interest and concern of the Alberta Power Commission and of the Provincial Government suggest that, when materials become available, there will be a programme of distributing central station power to farms in Alberta. It would be unreasonable to expect that all farms in the Province would be served in a period of years. Indeed, so far as can be foreseen, it would appear unwise to attempt to take central station power to farms in many parts of the Province. In these parts the use of the individual farm plant would still seem to be preferable. The individual farm plant has an important place in any programme of farm electrification in Alberta.

In an earlier article brief reference was made to farm plants, and to enquiries being made into their operation. Further information is now

available as the result of a survey made by Mr. A. R. Brown on behalf of the Alberta Power Commission.

Four types of plant are found on Alberta farms. The most common is the type driven by a gasoline engine, although the predominance of the engine-driven plant is being challenged by the wind-charged plant. There is also a growing tendency to instal a combined plant consisting of a wind tower with an auxiliary gasoline engine. A few farms with large power requirements have small diesel plants.

Each of the three main types of plant has its advantages and disadvantages. The gasoline plant requires less initial investment than the others and provides reliable and continuous service, but operating costs are relatively high. The wind plant generally costs slightly more than the engine plant, and may fail to provide energy at certain times, but operating costs are low. The combined plant naturally involves a larger investment, but continuous service is assured, and the experience of farmers operating this type of plant indicates that the cost of energy is lower than in the case of engines alone.

With from $400 to $790 invested in a plant, interest and depreciation charges represent a large part of the total costs. The proper allowance for depreciation is difficult to arrive at. Engine plants should last fifteen or twenty years with reasonable care. Wind plants might well last longer but there is not much experience to go on. Most wind plants have been only recently installed. The survey indicates that the average cost per month, including interest and depreciation, is from $4.00 to $6.00 for wind-driven plants, $6.00 to $8.00 for the gasoline plants, and $7.00 to $8.50 for the combined plants. The power generated from the combined plants is generally greater, which reduces the cost of energy provided.

The survey of farm plants points to some important general conclusions. First, farmers who have had experience with electric plants find them reliable, and are well-satisfied with the service they get from them. The equipment is good, and it is up to the farmer to get the most out of it. Second, many plants are giving less than optimum service because they have been improperly or poorly installed. The place and manner of installation will make a considerable difference to the service obtained. Third, many farmers who have plants are making much less than full use of them. Because of the overhead, less than full use results in high cost per unit of energy provided. Limited use means limited service.

Fourth, most farmers who have installed plants of low capacity wish that their plants were larger. These farmers have experienced the advantages of electrification, and are anxious to get more power, more appliances and more service. There is a fairly clear trend in the direction of larger plants. Fifth, the trend to the combined plant has been mentioned above. This merely provides another illustration of the desire for more power and for a wider range of appliances.

These conclusions suggest that the farmer who is considering installing a plant should make certain that the capacity of the plant is large enough to give him all the service he wishes, that the plant is properly installed in the place which will make it most useful to him, and that he has enough appliances to make the most effective use of the capacity he has. To ensure these things he should get as much information and advice as possible.

There is perhaps one exception to the rule that larger sizes of plant are to be preferred. In some districts of the Province where farms are in the process of being developed, or where farming on a small scale is combined

with other activities, the power requirements are not great, and may be limited to a few lights in the dwelling house. Here the large plant would mean excess power and excessive investment. In the survey of farm plants a few farms were found with small 6-volt wind chargers. The annual costs of operating these plants, counting interest and depreciation on the tower and batteries, averaged about $10.00. Plans are available for the home construction of 6-volt plant, using automobile generators and batteries. Perhaps only a few farmers would be prepared to make their own plants; but perhaps they could be made in local manufacturing and assembling plants. There are probably many farms in this Province where this type of plant would serve a useful purpose; and would be preferable to the alternatives. It would, of course, be poor policy to instal so small a plant on farms of any size, and with substantial power requirements.

The general outlines of a programme to provide electrical energy to Alberta farms seem to include the following:

(1) Some aid from the senior governments, including funds provided out of general revenues, to reduce the cost of energy to farm users.

(2) Advisory services to ensure that farms are equipped in the most advantageous way, and that full use is being made of the capacity available.

(3) The extension of farm distribution lines off existing transmission systems, in areas in which the density of farms is relatively high. This selection of areas would have the result of serving the largest number of farms from a given expenditure of money and effort.

(4) The promotion of the use of the individual farm plant in other areas of large and well-developed farms.

(5) Encouraging local production and installation of small 6-volt plants in those parts of the Province where farms are small and in the process of development.

(6) In opening up new areas for farm settlement consideration should be given to the location of farms and farm buildings so that power may be more conveniently taken to them.